

Material Safety Data Sheet

Distilled Mustard (HD)

Revised: 21 December 2004

Section I - General Information

Manufacturer's Address:

U.S. Army Edgewood Chemical Biological Center (ECBC)

ATTN: AMSRD-ECB-CB-CR

Aberdeen Proving Ground, MD 21010-5424

Business Phone: 410-436-4411 or 4414, Monday through Friday during the hours of 8:00 AM to 4:30 PM EDT

CAS Registry Number: 505-60-2

Chemical Name: Bis- (2-chloroethyl) sulfide

Trade name and synonyms:

H; HD; HS

Mustard Gas

Sulfur mustard; Sulphur mustard gas

Sulfide, bis (2-chloroethyl)

Bis (beta-chloroethyl) sulfide

1,1'-thiobis(2-chloroethane)

1-chloro-2 (beta-chloroethylthio) ethane

Beta, beta'-dichlorodiethyl sulfide

2,2'-dichlorodiethyl sulfide

Di-2-chloroethyl sulfideBeta, beta'-dichloroethyl sulfide

2,2'-dichloroethyl sulfide

EA 1033

Ipmit

Kampstoff "Lost"; Lost

S-Lost; S-yperite; Schewefel-lost

Senfgas

Yellow Cross Liquid

Yperite;Y

Chemical Family: Chlorinated sulfur compound

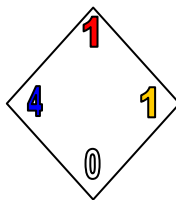
Molecular Formula and Structural Formula:

C₄ H₈ Cl₂ S

ClCH₂CH₂SCH₂CH₂Cl

NFPA 704 Signal:

Health - 4
Flammability - 1
Reactivity - 1
Special - 0



Section II - Ingredients

Ingredients/Name: Sulfur Mustard

Percentage by Weight: 100%

Section III - Physical Data

Boiling Point: 218 °C (424.4 °F); at atmospheric pressure HD starts to decompose below the boiling point.

Vapor Pressure (torr): 0.106 @ 25 °C

Vapor Density (relative to air): 5.5

Solubility: HD is practically insoluble in water; solubility of HD in distilled water is 0.92 g HD/100 g @ 22 °C. HD is freely soluble in fats and oils, gasoline, kerosene, most organic solvents and chemical warfare agents.

Specific Gravity (H₂O=1): 1.27 @ 25 °C

Freezing/Melting Point (°C): 14.45 °C

Liquid Density (g/mL): 1.2685 g/mL @ 25 °C

Volatility (mg/m³): 906 @ 25 °C

Viscosity (Centipoise): 5.175 @ 20 °C

Molecular Weight: 159.07

Appearance and Odor: Pale yellow to dark brown oily liquid; colorless when pure. Garlic-like or horseradish odor.

Section IV - Fire and Explosion Data

Flashpoint: 105 °C

Flammability Limits (% by volume): Unknown

Extinguishing Media: Water, fog, and foam, CO₂. Avoid use of extinguishing methods that will cause splashing or spreading of HD.

Special Fire Fighting Procedures: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving HD should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, fire-fighting personnel should wear full firefighter protective clothing (flame resistant) during chemical agent fire-fighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where fire fighters are responding to a chemical accident/incident for rescue/reconnaissance purposes they will wear appropriate levels of protective clothing (See Section VIII).

Do not breathe fumes. Skin contact with agent must be avoided at all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with the agent liquid or vapor can be fatal.

Section V - Health Hazard Data

Airborne Exposure Limits (AEL) ²:

Worker Population Limit (WPL) 8-hr TWA ¹ mg/m ³	STEL 15-min TWA ¹ mg/m ³	IDLH ¹ mg/m ³	General Population Limit (GPL) 12-hr TWA ¹ mg/m ³
0.0004	0.003	0.7	0.00002

¹ These values can be found in the DA, Office of the Assistant Secretary, Installations and Environment memo, subject: Implementation Guidance Policy for New Airborne Exposures Limits for GB, GA, GD, GF, VX, H, HD, and HT, 18 June 2004.

² To date, the Occupational Safety and Health Administration (OSHA) have not promulgated a permissible exposure concentration for HD.

Routes of Entry: The routes of entry for mustard agents are inhalation and ingestion, as well as eye and skin contact.

Effects Of Exposure: HD is a vesicant (causing blisters) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues, which are especially sensitive. The rate of detoxification of HD in the body is very slow and repeated exposures produce a cumulative effect.

HD is a human carcinogen as cited by the International Agency for Research on Cancer (IARC). HD has also been shown to be mutagenic in animals.

Signs and Symptoms: The acute signs and symptoms following mustard exposure are not immediate; they are delayed in appearance. The duration of the latent period and the degree of injury are both dependent on the severity of exposure as well as organs affected. The delay of onset is typically 4 to 6 hours but may range less than 1 hour up to several days.

The eye is the most sensitive organ system to mustard. Mild symptoms to mustard include inflammation, conjunctivitis possibly with lacrimation, grittiness in the eye, and erythema (reddening) of the lids and conjunctiva. Severe symptoms include photophobia, blepharospasm, pain, corneal erosion, ititis, conjunctival vascularization, ulceration and corneal opacification (blindness).

Skin exposure to mustard vapor is marked by delayed appearance. Mild symptoms include erythema, itching, burning and pain. Severe symptoms include vesication or blisters. Liquid mustard exposure on skin may result in

an area of gray-white necrotic skin surrounded by erythema and vesication.

Inhalation of mustard vapor causes damage primarily to the nasopharyngeal, laryngeal and tracheobronchial mucosa. Respiratory symptoms to mustard vapor vary in degree of onset and intensity related to the degree of exposure. Mild symptoms to the airway include inflammation of the respiratory mucosa, congestion, coughing and edema. Severe symptoms include necrosis, sloughing of the mucosa and chemical pneumonia. Repeated exposures or prolonged inhalation can cause bronchiectasis or chronic bronchitis.

Gastrointestinal symptoms of intense mustard exposure include nausea and vomiting.

Like other alkylating agents, systemic absorption results in injury to the bone marrow, lymph nodes, and spleen producing leukopenia and thrombocytopenia. Other systemic effects include: fever; CNS depression; bradycardia or cardiac irregularities; hemoconcentration; and shock.

Chronic Exposure: Chronic mustard-induced illnesses are most common in the eyes, skin, respiratory track or bone marrow. Delayed, recurrent keratoconjunctivitis of the eyes has been documented in some cases as long as 45 years from original exposure. Healing of mustard blisters may result in skin exfoliation and areas of hypo- or hyperpigmentation. Exposure can cause chronic lung impairment (productive cough, shortness of breath, chest pain, frequent pulmonary infections and bronchitis). Prolonged human exposure has been associated with cancer of the tongue, paranasal sinus, larynx, bronchus, lung, and mediastinum (cavity between the right and left lung). Tumors observed have been of squamous (scale like) or undifferentiated (altered) cell types. Consider the possibility of skin cancer because of the frequency of this lesion in animal studies. Since sulfur mustard agent is similar in its effects to nitrogen mustard, which has been associated with human leukemia, this disease might also be expected to occur in humans chronically exposed to mustard.

Toxicity Values:

Vapor (Inhalation/Ocular)¹

ECt50 (Mild) = 25 mg-min/m³

ECt50 (Severe)² = 100 mg-min/m³ {3}

LCt50 = 1000 mg-min/m³

Vapor (Percutaneous)^{4,5}

ECt50 (Mild) = 50 mg-min/m³

ECt50 (Severe)² = 500 mg-min/m³

LCt50 = 10000 mg-min/m³

Liquid (Percutaneous)

ED50 = 600 mg/70 kg man

LD50 = 1400 mg/70 kg man

¹ Estimates for inhalation vapor exposure are based on a minute volume (MV) of 15 liters. The exposure time is 2 minutes.

² Severe effects may also include death.

³ Recent studies have determined that this value may be 75 mg-min/m³.

⁴ Personnel are masked.

⁵ Values for percutaneous vapor are for moderate temperatures (85 °F and below). The effective dosages for hot temperatures (85 °F and above) will be less by at least a factor of 2.

Emergency And First Aid Procedures:

Prior to rendering first aid, take steps for self protection such as donning a protective mask and other protective equipment. **Immediately** remove individual from contaminated area. Decontaminate the individual as indicated below.

Vapor Exposure: Vapor-exposed mustard agent casualties should be decontaminated by removing all clothing in a clean air environment and shampooing or rinsing the hair to prevent vapor off-gassing.

Liquid Exposure: Wash the skin surface and hair in warm or hot water at least three times. The rapid physical removal of a chemical agent is essential. Scrubbing of exposed skin with a stiff brush or bristles is discouraged, because skin damage may occur and may increase absorption of agent. Use liquid soap (dispose of container after use and replace), copious amounts of water, and mild to moderate friction with a single-use sponge or washcloth in the first and second washes. The third wash should be a rinse with copious amounts of warm or hot water. Shampoo can be used to wash the hair. If warm or hot water is not available, but cold water is, use cold water. Do not delay decontamination to obtain warm water. Two permissible alternative skin decontaminants include the M291 Skin Decontaminating Kit (SDK) and a 0.5% sodium hypochlorite solution. (**NOTE:** The use of the M291 SDK and/or 0.5% sodium hypochlorite on skin is appropriate in situations where soap and water may not be as efficacious in physically removing particular types of mustard agents, such as those used in certain research and development laboratories. Neither soap and water, 0.5% sodium hypochlorite or the M291 SDK have been shown to be more efficacious than the other for physically removing every type of mustard agent from the skin.) If used, the 0.5% sodium hypochlorite should be applied with mild to moderate friction, with a single-use sponge or washcloth in the first and second washes. The third wash should be a rinse to remove any residual sodium hypochlorite with copious amounts of warm or hot water.

Eye Contact: **Immediately** leave area of contamination and begin flushing eyes, mucous membranes, or open wounds with sterile saline or water. Flush the eyes **Immediately** with sterile saline or water by tilting the head to the side, pulling the eyelids apart with gloved fingers and pouring slowly into the eyes. A Morgan lens may also be used for continuous eye irrigation. As soon as possible, don respiratory protective mask and leave area of contamination.

Ingestion: Do not induce vomiting. First symptoms are likely to be gastrointestinal. Seek medical attention **Immediately**. **Do not handle vomited material to avoid further contamination.**

Inhalation: If breathing is difficult, administer oxygen. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination is present. Seek medical attention **Immediately**.

NOTE: The Office of the Surgeon General is responsible the medical guidance provided in this MSDS. Questions concerning medical guidance provided in the this MSDS may be addressed to HQDA (DASG-PPM-NC), 5109 Leesburg Pike, Falls Church, VA 22041-3258.

Section VI - Reactivity Data

Stability: A small amount of degradation occurs when stored in steel containers for over 50 years. This degradation appears to be caused by the formation of solid deposits “heels” comprised of a six membered ring cyclic sulfonium ion {1-(2-chloroethyl)-1, 4-dithianium chloride}, HD and Fe, which are detected at the bottom of containers.

Decomposition Temperature: 180 °C

Rate of Hydrolysis: HD on or under water undergoes hydrolysis only if dissolved. The rate of HD hydrolysis is controlled by the rate of mass transfer and is very slow.

Hydrolysis Products: Hydrogen chloride, thiodiglycol and sulfonium ion aggregates one of which is also very toxic.

Action on Metals and Other Materials: Very little when pure. The corrosion rate of HD on steel is 0.0001 in./month @ 65 °C using munitions grade HD.

Hazardous Polymerization: Does not occur.

Section VII - Spill, Leak, And Disposal Procedures

Steps To Be Taken In Case Material Is Released Or Spilled: Only personnel in full protective clothing (See Section VIII) will be allowed in an area where HD is spilled. See Section V for emergency and first aid instructions.

Recommended Field Procedures: The HD should be contained using vermiculite, diatomaceous earth, clay or fine sand and neutralized as soon as possible using copious amounts of nominal 5% sodium hypochlorite solution. Scoop up all material and place in an approved DOT container. Cover the contents with decontaminating solution as above. The exterior of the container will be decontaminated and labeled according to EPA and DOT regulations. All leaking containers will be over packed with sorbent (e.g. vermiculite) placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material in accordance with waste disposal methods provided below. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the STEL (See Sections V and VIII).

If 5% sodium hypochlorite solution is not available then the following decontaminants may be used instead and are listed in the order of preference: **Calcium Hypochlorite and Super Tropical Bleach Slurry (STB).

****WARNING:** DO NOT USE PURE SOLID, UNDILUTED CALCIUM HYPOCHLORITE (HTH); it will BURN UPON CONTACT with liquid mustard.

Recommended Laboratory Procedures: Use a minimum of 65 grams of decontamination solution for each gram of HD. Allow 24 hours for decontamination to take place. Agitate solution at least one hour. Agitation is not necessary after the first hour. Test for presence of active chlorine by use of acidic potassium iodide solution to give free iodine color. Adjust the resulting solution pH to between 10 and 11.

Place three milliliters (ml) of decontaminated solution in a test tube. Add several crystals of potassium iodine and swirl to dissolve. Add 3 ml of 50 wt.% sulfuric acid: water and swirl. Immediate iodine color shows the presence of active chlorine. If negative, add additional decontaminant to the decontaminated solution, wait two hours and test again for active chlorine. This works for either 5.5% sodium hypochlorite or 10% calcium hypochlorite decontamination solutions. Scoop up all materials and clothing and place in an approved DOT container. The exterior of the container will be decontaminated and labeled according to EPA and DOT regulations. All leaking containers will be over packed with sorbent (e.g. vermiculite) placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of contents according to Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the STEL (See Sections V and VIII).

NOTE: Surfaces contaminated with HD, then rinsed and decontaminated may evolve sufficient HD vapor to produce a physiological response. HD on laboratory glassware may be oxidized by its vigorous reaction with concentrated nitric acid.

Waste Disposal Method: Open pit burning or burying of HD or items containing or contaminated with HD in any quantity is prohibited. Waste HD and associated decontamination solutions may be Resource Conservation and Recovery Act (RCRA) regulated hazardous wastes due to a State listing of the chemical agent, or the characteristics of the waste, to include contaminants. An evaluation of the Federal and State waste disposal regulations must be conducted to determine the appropriate disposal method.

Section VIII - Special Protection Information

Respiratory Protection:

Unprotected Workers:

<u>Concentration (mg/m³)</u>	<u>Time Limits</u>
Less than or equal to 0.0004 ¹	8 hours
Up to or less than 0.0016	2 hours ²

Protected Workers:

Type of Respiratory Protection Worn (based on air monitoring results):

1. M40 Military Mask, CBRN NIOSH Approved Respirator

<u>Concentration (mg/m³)</u>	<u>Time Limits</u>
Not greater than 0.15	Up to 15 minutes ³

2. Air Supply Line with Full Face Respirator

<u>Concentration (mg/m³)</u>	<u>Time Limits⁴</u>
0.0004 to 0.7 ⁵	Time limit will be kept at a minimum to perform the operation, and will be dictated by the local Heat Stress Program for personal protective equipment and clothing.

3. Air Supply Line with Full Face Respirator and Auxiliary Self-contained Breathing Apparatus (SCBA), or SCBA

<u>Concentration (mg/m³)</u>	<u>Time Limits⁴</u>
Greater than 0.7	These concentrations should be expected only in emergency situations. Operations should not be conducted at these concentrations.

¹ As an 8-hr TWA average.

² Maximum continuous time at this concentration. Equivalent to 8-hr TWA. Source: Implementation Guidance Policy for Revised Airborne Limits for GB, GA, GD, GF, VX, H, HD, and HT, Dept of Army, Office of the Assistant Secretary of the Army Installations and Environment, 18 June 2004. See Table 5.

³ Based on APF of 50 times the STEL (0.003 mg/m³), which is a 15 minute TWA. Only one excursion to this concentration is allowed per an 8 hour working day.

⁴ For SCBA wearers, time limit is constrained by life of the air cylinder (maximum of 30 to 45 minutes). For Air Supply wearers, time limits should be kept to a minimum. Should use of the auxiliary SCBA be necessary, time limit will be constrained by the life of the breathing air cylinder, and egress from the area must be performed before its expiration.

⁵ The Immediately Dangerous to Life and Health Value.

Ventilation

Local Exhaust: Mandatory. Must be filtered or scrubbed to limit exit concentrations. Air emissions shall meet local, state and federal regulations.

Special: Chemical laboratory hoods will have an average inward face velocity of 100 linear feet per minute (lfpm) +/- 20% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods will have an inward face velocity of 150 lfpm +/- 20%. Laboratory hoods will be located such that cross drafts do not exceed 20% of the inward face velocity. A visual performance test using smoke producing devices will be performed in assessing the ability of the hood to contain agent HD.

Other: Recirculation of exhaust air from agent areas is prohibited. No connection between agent area and other areas through the ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested semiannually or after modification or maintenance operations. Operations should be performed 20 centimeters inside hoods.

Protective Gloves: Butyl Rubber gloves M3 and M4
Norton, Chemical Protective Glove Set

Eye Protection: As a minimum, chemical goggles will be worn. For splash hazards use goggles and face shield.

Other Protective Equipment: For laboratory operations, wear lab coats, gloves and have mask readily accessible. In addition, daily clean smocks, foot covers, and head covers will be required when handling contaminated lab animals. In the case of a spill, the minimum protective clothing should be Level B after the site has been evaluated, otherwise Level A.

Monitoring: Available monitoring equipment for agent HD is the M8/M9 detector paper, blue band tube, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAAMS), Automated Continuous Air Monitoring System (ACAMS), CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED), the Miniature Chemical Agent Monitor (MINICAM), and Real Time Analytical Platform (RTAP). Real-time, low-level monitors (with alarm) are required for HD operations. In their absence, an Immediately Dangerous to Life and Health (IDLH) atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

Section IX - Special Precautions

Precautions To Be Taken In Handling and Storing: When handling agents, the buddy system will be incorporated. No smoking, eating, or drinking in areas containing agents is permitted. Containers should be periodically inspected for leaks, (either visually or using a detector kit). Stringent control over all personnel practices must be exercised. Decontaminating equipment will be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands using plenty of soap and water before leaving at the end of the workday.

Other Precautions: HD should be stored in containers made of glass for Research, Development, Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent containers will be stored in a single containment system with in a laboratory hood or in double containment system.

For additional information see "AR 385-61, The Army Toxic Chemical Agent Safety Program," "DA Pam 385-61, Toxic Chemical Agent Safety Standards," and "DA Pam 40-173, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT"; and DA Implementation Guidance

Section X - Transportation Data

NOTE: Forbidden for transport other than via military (Technical Escort Unit) transport according to 49 CFR Part 173.7(b), DOD 4500.9-R and AR 50-6.

Proper Shipping Name: Toxic liquids, organic, n.o.s. (Bis- (2-chloroethyl) sulfide)

UN ID Number: UN2810

DOT Hazard Class: 6.1, Packing Group I, Inhalation Hazard Zone A

DOT Label: Poison Inhalation Hazard or Toxic Inhalation Hazard. See 49 CFR 172.400a(a)(3) for exceptions to unit packaging labeling and 173.7(b) for other exceptions when material is transported by Technical Escort Units.

NOTE: "Poison" and "Toxic" are used interchangeably for all markings, labels and placards in continental US transportation. "Toxic" is required for international transportation.

DOT Marking: Toxic liquids, organic, n.o.s. (Bis- (2-chloroethyl) sulfide) UN 2810, Inhalation Hazard Zone A

DOT Placard: Poison Inhalation Hazard or Toxic Inhalation Hazard

Emergency Accident Precautions and Procedures: See Sections IV, VII and VIII.

Precautions To Be Taken In Transportation: Motor vehicles will be placarded regardless of quantity. Drivers will be given full information regarding shipment and conditions in case of an emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipment of agents will be escorted in accordance with AR 740-32.

The Edgewood Chemical Biological Center (ECBC), Department of the Army believes that the data contained herein are actual and are the results of the tests conducted by ECBC experts. The data are not to be taken as a warranty or representation for which the Department of the Army or ECBC assumes legal responsibility. They are offered solely for consideration. Any use of this data and information contained in this MSDS must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.